Auditing your radioactive sources

In Bulletin 255, we reminded users of radioactive materials in schools of the administrative procedures they should be carrying out in order to work safely and comply with the law. In this issue, we look at the sorts of sources that are permitted for use in schools.

If your school possesses something other than a permitted source, please get in touch with SSERC immediately; we will be able to help. Please always rely on our advice regarding what is permitted. "Complies with all legislation" or "no permission required to purchase" are phrases that may well be true for a source on sale, and destined for use in America or even England, but they may not be applicable to Scotland.

1) "Standard" source

At present, these are the most common sealed sources in use in schools. They have been supplied by Griffin, Harris, Irwin, Nicolson for decades and are still available from Harris. The only ones that should still be in schools are americium (^{241}Am), strontium (^{90}Sr) and cobalt (^{60}Co), respectively used to demonstrate the properties of α, β and γ radiation. The sources are stored in lead-lined pots in hardwood boxes. Typically, these sources have activities between 3.7 kBq and 185 kBq.

These sources require to be handled by tongs. They have an excellent safety record and have now been shown to comply with ISO 2919. There were also radium and plutonium sources of this design in use in schools. Most, but not all of these should have been disposed of. If you discover that you still own some, please contact the RPA.

2) Hi Tech/QSA Global source

Many schools re-equipping with sealed sources are opting for this type. They are available as ^{241}Am, ^{60}Co, ^{137}Cs, ^{22}Na, ^{90}Sr, but the sodium source is not to be used in schools - **do not buy it**. The properties of gamma radiation can be studied with either ^{60}Co or ^{137}Cs. Typically these sources have activities between 74 kBq and 370 kBq. The sources can be handled without tongs and come with their own storage pots. They can be mounted in standard boss heads. These sources comply with ISO 2919.

3) Cooknell ionisation chamber with thoriated gas mantles

Some, though not all, gas mantles have been thoriated. Thorium decays to radon (^{220}Rn), also known as thoron. This isotope of radon has a half life of 54 s.

The mantles are kept in a plastic bottle that can be connected to an ionisation chamber. The radon is transferred to the chamber by loosening a clip and squeezing the bottle. The small current between the electrodes in this ionisation chamber is proportional to the activity of the radon. It is amplified by an extra-high impedance amplifier. The output can be displayed on a voltmeter or data logger.

4) Caesium/barium isotope generator

This source is used to demonstrate half life. Using a process called eluting (effectively "washing out"), a special fluid is passed through the generator, which contains beads impregnated with ^{137}Cs. The caesium itself is not washed out, but a radioactive isomer of barium, ^{137m}Ba passes with the liquid into a glass receiving vessel. The barium decays, with a half life of 2.6 minutes, to a stable form of the same isotope. Thus, after half an hour, the liquid is not significantly radioactive and can be disposed of down a drain.

There are two forms of this generator available, with activities of 33 kBq and 370 kBq - **do not buy the latter or the Pasco "10 microcuries" source and if you have one, please let us know.** As well as a leak test, this source requires a simple annual "bleed through" test to check that no caesium is being removed from the generator during elution.

5) Protactinium generator

The protactinium generator consists of approximately 1.5 g of uranyl nitrate in concentrated hydrochloric acid plus an organic solvent, hexyl ethanoate, that is immiscible with water. This is contained in a sealed bottle. Protactinium-234 has a half life of around 70 seconds and is an element in the decay series of

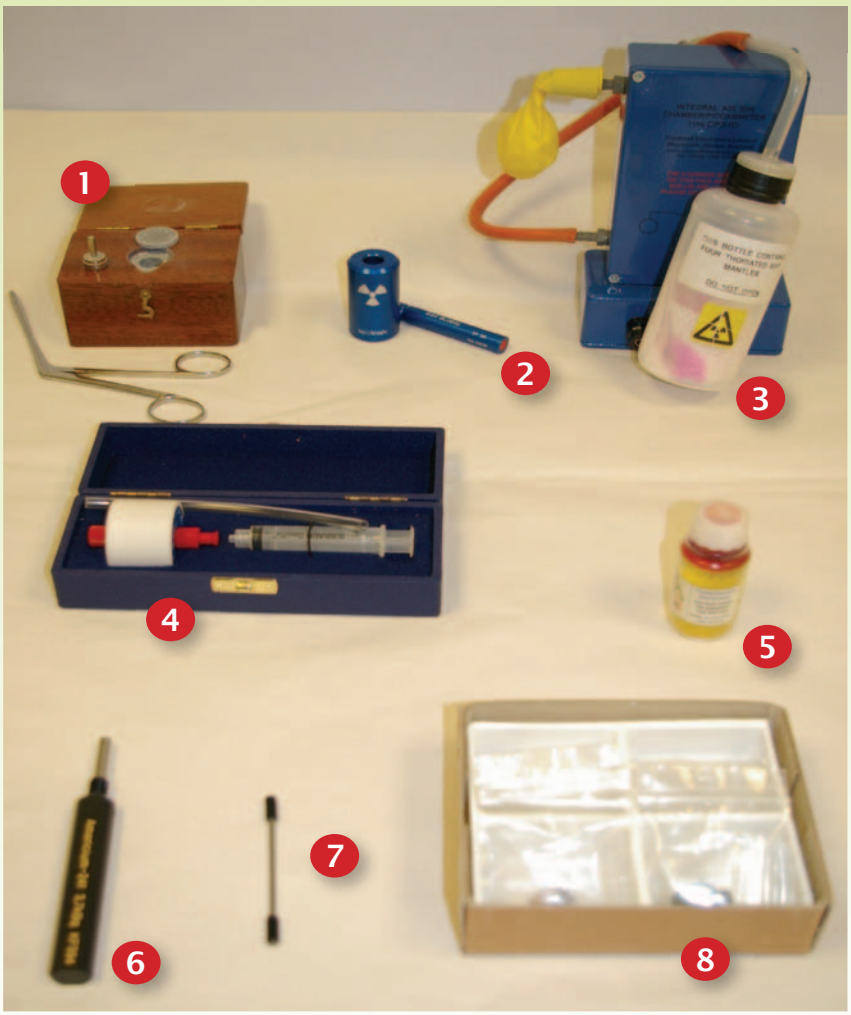

Figure 1 *- Sources for use in Scottish schools.*

uranium-238. When the generator is shaken, protactinium is taken up by the organic solvent. When the liquids settle, the organic solvent bearing the protactinium remains in a layer at the top. When not in use or when being transported, the protactinium generator is stored within a larger bottle, within which it rests on a foam pad.

The activity of the protactinium generator is estimated to be in the region of 20 kBq but much of the radiation will be absorbed by the container and the liquid within it. The protactinium decays by emitting beta particles whose energy spectrum peaks at 2.3 MeV. These can penetrate the walls of their container.

Note that you might have significant "end of life" disposal costs with this source due to the chemical toxicity of the uranium. The recommended working life of this source is 8 years. **Do not make your own protactinium generator.**

6) Frederiksen cloud chamber source

This americium source (^{241}Am), with an activity of 3.7 kBq, is designed for cloud chambers.

7) Thoriated TIG welding rods

Some TIG (tungsten inert gas) welding rods contain small amounts of thorium. This makes them ideal as sources for use in cloud chambers. The rod in the picture is a few cm long and comes with Lascell's Peltier-cooled cloud chamber, as given to all local authorities by SSERC in 2015. The activity of these rods is likely to be around 3 kBq. If you have a radioactive sources storage cabinet, keep them there. If not, it is OK to store them with the cloud chamber. **Do not saw or grind the rods.**

8) Radioactive minerals

These rocks are for showing that some minerals are naturally radioactive. They should not be used to demonstrate the properties of radiation, for example absorption, because, where possible, you are obliged to work with a sealed source and the aforementioned investigation could be done using such a sealed source.

Note that the rocks should not be taken out of their bags.

You are also allowed to have a smoke alarm in order to show that it contains a radioactive source. You must not take it apart or use the source for experiments. Some schools have objects made of uranium glass. This is fine but in general don't accept or bring in radioactive items from home or elsewhere. This includes glow-in-the-dark watches and dials. Any uranium or thorium compounds should have been disposed of. These still turn up in chemical stores, unfortunately. Keep a special eye out for sachets of thorium compounds in polythene "radon generator" bottles. We have never sanctioned the purchase of the disc-shaped Pasco sources because they have not been shown to comply with ISO 2919. We will now not authorise the purchase of the acrylic-handled Frederiksen sources for the same reason. As we said, if you find anything you don't think you should have, please get in touch.